Protection Provided by the Closed System

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Under the California Code of Regulations, employers must provide closed systems for employees that mix or load liquid pesticides in toxicity category I, or load diluted liquid mixes derived from dry pesticides in toxicity category I. Historically, a closed system has been shown to reduce the number of illnesses caused by toxicity category I pesticides (Rutz, 1987). Illnesses of mixer/loaders resulted from uses of category I liquid pesticides were reduced from 52 cases in 1981 to 16 cases in 1985. A closed system must conform to California's requirements (Rutz and Gibbons, 1992). In this case "closed system" is defined as a mechanical transfer procedure for removing a pesticide from its original container, rinsing the emptied container, and transferring the pesticide and rinse solution through connecting hoses, pipes and couplings that are sufficiently tight to prevent exposure of any person to the pesticide or rinse solution. Rinsing is not required when the pesticide is used without dilution, the container is returnable or a reusable container that will be sent back to the registrant or the container is larger than 60 gallons.

In situations where exposures of mixer/loaders to pesticides in other toxicity categories are excessive, exposure mitigation measures are needed. Use of a closed mixing/loading system can be very helpful in mitigating exposure to an acceptable level. The Worker Health and Safety branch, Department of Pesticide Regulation adopted a default protection value of 95% for a closed mixing/loading system. This value was basically derived from studies using a closed system versus open pouring with the same pesticide. The default 95% protection value was derived based upon the following studies.

A very comprehensive study was conducted by Ciba-Geigy using a closed system (Farm-Pak® CS) versus open pouring (Morse and Stecker, 1988). Primatex, composed of atrazine and metolachlor, was used in this evaluation. There were four replicates each for using a closed system and open pouring. One replicate was the result of mixing/loading for 6 consecutive sprayer loads. This study determined potential dermal exposure of mixer/loaders using the two different mixing/loading systems. Table 1 showed the results of the study.

Table 1. Mixer/loader exposure to atrazine and metolachlor using a closed system and open pouring.

	Average potential dermal exposure (mg)	
	Atrazine	Metolachlor
Conventional method (open pour)	5142	12288
Closed system (Farm-Pak CS)	187	630
Percent protection	96.4	94.9

Exposure studies conducted by Gates measured exposure potential during mixing and loading chlordimeform. The results of these studies were reviewed and summarized by Jacobs (1984). Chlordimeform is rapidly absorbed through the skin and almost totally excreted in urine. Therefore, concentrations of this chemical in workers' urines were used to estimated exposure. An average of 3 ppm chlordimeform in urine was found for relatively unprotected workers. In a subsequent study using a Soil Serve closed system, an average concentration of 0.075 ppm chlordimeform in urine was detected. This gives a protection value of 97.5%. Other studies

using closed systems (a bulk chemical system or the Goodwin System), revealed an average daily urine concentration below 0.1 ppm chlordimeform in 95% of the 5,000 samples analyzed. This is also a good indication that a closed system can give a very high degree of worker protection of up to 96.7%.

The last study was conducted by Maddy *et al*. (1980). The results of this study were also reviewed and summarized by Jacobs (1984). The average exposure estimate for mixer/loaders to nitrofen (TOK) was 3.5 mg per day when closed systems were used, whereas, the exposure range was 100 to 500 mg per day for open pouring by hand. By using the mid range of hand pour exposure of 250 mg, the protection value was estimated to be 98.6 percent.

From the above mentioned studies, we are confident that a closed system can provide substantial protection to mixer/loaders. An average protection from these studies is 96.8±1.4 percent (Mean ±SD of 96.4, 94.9, 97.5, 96.7, 98.6). A conservative protection value of 95% is presently used by the California Department of Pesticide Regulation. This default value will be updated periodically as data are available. Chemical resistant gloves are recommended during the operation of a closed system.

Even though a closed system plus chemical resistant gloves provide a high degree of protection, a number of malfunctions of the system can occur (Jacobs, 1984). Soft parts (hoses, O-rings, gaskets, etc.), hose connections, pumps, measuring and metering systems can wear out and cause sudden leakage in the system. These incidents, when they occur, can cause high exposure to mixer/loaders during work activities. In order to reduce this sudden exposure, we suggest a chemical resistant apron be used.

Conclusion

1. A closed system that conforms to California's requirements provides an average protection of 96.8%. A default protection value of 95% is presently adopted by the California Department of Pesticide Regulation.

2. a) Under the new federal worker protection standard (FR, 1992), persons using a closed system to handle pesticide products with a signal word of "DANGER" or "WARNING" may substitute work clothing, chemical resistant gloves, and a chemical resistant apron for other labeling specified personal protective equipment.

   b) Persons using a closed system to handle pesticide products with the signal word "CAUTION" may substitute work clothing for other labeling specified personal protective equipment

   c) Persons using a closed system that operates under pressure shall wear protective eyewear in addition to the personal protective equipment listed in 2a and 2b. Persons using any closed system shall have all other labeling specified personal protective equipment immediately available for use in an emergency.

References

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